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Original Research

Radiographic Estimation of Chronological Age using Mineralization of Third Molars in Coastal Andhra, India

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Abstract:

Background: Age estimation is an important factor in establishing the identity of a person. Among various techniques, dental age estimation is helpful in estimating the age in children above 16 years of age. Determination of age using developmental stages of teeth is more useful than using tooth eruption.

Materials and Methods: A total of 550 orthopantomographs of 248 males and 302 females aged between 15 and 22 years were taken and evaluated by Demirjian's tooth mineralization stages. Statistical assessment was done using logistic regression analysis.

Results: Complete apical closure of third molars was observed at the age of 20.4 years in 50% of males. Gender is also thought to influence mineralization and males showed early apical closure than females. Mean value testing is also done but showed influence of high and lower end age groups on age estimation.

Conclusion: Finally, we conclude that, though the exact age of a person cannot be determined, the Demirjian's stage at which 18 years of age is attained can be found out.

Key Words: Age estimation, demirjian, regression analysis, tooth mineralization

Introduction

Age estimation of an individual has gained a lot of importance in forensic dentistry as it is one of the factors in establishing

the identity of a person. As the frontiers of dentistry are being widened, dentist has been taken as an expert witness in legal room proceedings in the field of forensic sciences to estimate the age.¹ It is important in various medico-legal issues, to differentiate between juveniles and adults and for chronological age estimation.² This is important because the laws portrayed are different at different ages. This difference can be clearly observed between a child less than 18 years of age and an individual who have attained 18 years of age. Under Indian Penal Code, a child under 14 years of age cannot be employed to work. Similarly, when a juvenile, a boy under 16 years and a girl under 18 years, commits an offense, he/she is confined to Juvenile home and shall not be sentenced to death or imprisonment.

Conventional methods used for age estimation include physical, dental and hand-wrist radiograph examination.³ The latter is most frequently used for skeletal maturity assessment as it provides an accurate estimation up to 16 years of age. However by this age, maturation is complete in almost 90% of subjects, and it is most often influenced by environmental factors.⁴ Hence, an alternative approach suitable for age estimation in children is used, which is based on dental development.³ Determination of age using developmental stages of teeth is more useful than using tooth eruption, as tooth formation is a continuous and progressive process, which can be followed radiographically. Moreover, the calcification rate is controlled by genes unlike tooth eruption that is influenced by environmental factors such as extraction of deciduous predecessors, impacted tooth, and tipping.³⁻⁵

Dental age estimation is not uniform from birth to maturity. In the younger age groups clinical eruption, Moorrees *et al.*⁶ chart, and Gustafson's chart⁷ are often used. However in the later stages between 15 and 26 years, the third molars are the only teeth still in development and thus help in assessing the chronological age of an individual based on the developmental stages of third molars proposed by Demirjian *et al.*^{8,9} The correlation between radiologically detected developmental stages of third molars and the actual chronological age help to estimate age in the transition zone between juvenile and adult status. With this background, we conducted a study to estimate the age of a child.

The main purpose of our study is to find out:

- Whether mineralization stages of third molar are useful to determine whether the child had attained 18 years of age
- If there is any difference in mineralization of third molars between genders
- At what age is the complete apical closure of the teeth noted.

Materials and Methods

After Review board approval, a total of 550 good quality orthopantomographs (OPGs) of healthy individuals (248 males, 302 females) belonging to the age group 15-22 years were collected from the college records between the years 2012-2014 and were analyzed. Based on the standard age group of 18 years for the examination, patients 3 years younger and 4 years older were included in the study.¹⁰ Individuals with incomplete medical and dental history; systemic diseases such as endocrine abnormalities, vitamin deficiencies; hypodontia and hyperdontia; if only 38 or 48 is present and any skeletal and dental abnormalities were excluded from the study. The number of individuals in each age group ranged between 50 and 109 (Table 1). The higher number of female individuals in the age groups 18 and 20 was only accidental.

Radiological examination of OPG's was limited to lower wisdom teeth, either 38 or 48. Only cases that could be classified clearly according to Demirjian stage were considered.¹¹ The name and age of the patient on the radiographs were blocked, and a code number was given. They were observed under the supervision of an expert in the field. In the case of different stages between left and right, the less advanced stage of development was included. The assessment was carried out according to the age, gender and Demirjian stages of tooth development.

Statistical evaluation

Statistical evaluations were carried out using the SPSS software. Both mean values and logistic regression statistical methods were done. Logistic regression is capable of predicting the probability of each Demirjian stage for each combination of variables (age, gender). 10%, 50%, 90% probability values have also been calculated for stages D-H. Mean value testing is frequently used in age diagnostics. Therefore, an additional analysis of mean values for developmental stages D-H and first standard deviation (SD) for 15-22 years was determined. To estimate the influence of age grouping on mean values, the high-end age groups 21 and 22 years and then the lower-ranking age groups of 15 and 16 years were eliminated.

Results

On analyzing the data, we have found that Demirjian Stages A and B were not observed in the 15-22-year-old age group. Stage C was seen in only 8 cases among 550 (1.45%) and was not observed in groups over 17 years.

- 27.09% (149/550) of the sample showed complete root growth (Stage H) by 22 years.

Table 1: Distribution of individuals in each age group.

Age (years)	Gender		Total
	Male	Female	
15	28	22	50
16	30	38	68
17	25	33	58
18	27	48	75
19	33	34	67
20	49	60	109
21	34	32	66
22	22	35	57
Total	248	302	550

Table 2: Mean values of developmental stages D-H and their first SD for different age groups.

Stage	Age		
	15-22 years	15-20 years	17-22 years
D (SD)	18.3 (1.18)	17.9 (1.40)	18.1 (1.22)
E (SD)	18.7 (1.24)	18.0 (1.24)	18.4 (1.24)
F (SD)	20.0 (1.12)	18.9 (1.12)	19.8 (1.20)
G (SD)	20.6 (1.18)	19.0 (1.32)	20.8 (1.28)
H (SD)	21.8 (1.2)	20.6 (1.10)	21.0 (1.16)

SD: Standard deviation

Table 3: Mean age (in years) for combination of gender and the 10%, 50%, 90% probability for attainment of tooth stages D-H.

Stage	Gender	10%	50%	90%
D	M	16.14	17.86	18.20
	F	15.48	16.0	17.94
E	M	16.78	18.62	19.40
	F	17.92	19.44	20.80
F	M	17.18	19.00	20.28
	F	18.00	21.20	21.66
G	M	17.66	19.54	20.62
	F	18.20	20.80	21.42
H	M	18.78	20.46	21.24
	F	17.84	21.16	22.86

- Only 12 out of 550 cases showed complete root growth by 18 years that constituted 2.18% of the total sample.

The mean values for the developmental stages D-H and their first SD for the age groups 15-22, 15-20 and 17-22 years were calculated (Table 2). The mean age (in years) for a combination of gender and the 10%, 50%, 90% probability for attainment of tooth stages D-H were also calculated (Table 3).

Discussion

The importance of age estimation has been increasing in forensic odontology to determine the age of an individual either an adult or a child in criminal law cases, in relation to school attendance, social benefits, employment and marriage.^{12,13} There are many methods of estimating the age and that using dental findings is one among them. Teeth being the strongest parts can withstand various external influences which would otherwise destroy the other tissues of the body. This makes them a valuable aid in post-mortem identification,¹⁴ which are also good indicators of people's age.¹⁵

In the younger age groups, as more teeth are in the process of formation and due to the presence of short intervals between the morphological stages, age estimation is more precise in them. But, in the later ages as the premolars and canines have already completed their formation, only third molars are in the process of formation. These are the only biologic indicators in this age interval, which help us to know the attainment of status of the majority and to differentiate between adult and juvenile.^{16,17}

The detailed description and clear radiographic illustrations of developmental stages of tooth, we chose Demirjian classification of mineralization stages. The other reason for opting this classification is based on the observation by Olze *et al.* who examined various types of classification like Demirjian *et al.* (1973), Gustafson and Koch (1974), Gleiser and Hunt (1955), Kullman *et al.* (1992), Harris and Nortje (1984) for age estimation. They concluded that Demirjian stages of development should be used for forensic age estimation while evaluating third molars because it showed the highest correlation between the temporal age and the estimated age.¹⁸

When the root anatomies of third molars of both the jaws were compared, the roots of maxillary teeth were not easily interpreted like that of the lower jaw.¹⁹ This may be due to the superimposition of the zygomatic process or due to the varied arrangement of the roots of maxillary third molars. According to Mesotten *et al.* and Mincer *et al.* maxillary third molars completed root growth earlier than mandibular third molars. So, in age estimation maxillary third molars are of less importance. So, we considered only mandibular third molars.²⁰

In our study, 550 OPGs of lower third molars of age groups 15-22 years were examined. On observing the mean values obtained (Table 2), we found that the lower third molars completed root growth by 21.8 years with an SD ± 1.2 years. To estimate the influence of aging on mean values the high-end age groups 21 and 22 years were excluded. This has led to the reduction of the mean value from 21.8 to 20.6 years with an SD ± 1.1 years. When the lower age groups 15 and 16 are excluded, the mean values showed a decrease to 21.0 years with an SD ± 1.16 years. Among all other stages, the mean value for stage G showed reduction of about 1.6 years when the high-end age groups have been excluded. Thus, when the results obtained are analyzed, we found that mean value testing yielded different results and were not reliable.

Logistic regression analysis of the data was also done which does not depend on the age group selected. Hence using these results the age at which complete apical closure of the roots occurs was determined. The results obtained showed that 10% of males showed complete root growth by 18.78 years in the lower third molars and the females by 17.84 years. When 50% column is observed, we notice that males complete root

growth 0.7 years earlier than females. But, 90% of males reach H stage only by 21.24 years and females by 22.86 years which is more appropriate.

Gender is also known to exert influence on root development. Levesque *et al.* (1981) observed that, third molar root formation and eruption occur in males ahead of females which are opposite to the pattern of development observed in all other teeth.²¹ In our study, among males, the age at which 10% of cases showed completed root growth of wisdom teeth is greater than 18 years, while females have completed earlier than 18 years. But, on observation of 50%, 90% probability values of all stages (D-H), males showed earlier root growth similar to the observation made by Levesque *et al.*

According to AMM Araujo *et al.* (2010), gender shows no significant difference in the development of mineralization stages of third molars.²² On contrary 50%, 90% probability values showed that males reach H stage 1.62 years earlier than females which was found to be statistically significant ($P = 0.00$). Thus, this study is in support of observation made by Mincer *et al.* (1993).

We also observed that, the mean age at which H stage was obtained is 21.8 ± 1.2 years, a value 1 year more than that obtained by Knell *et al.* in 2009¹⁰ and 1 year less than that obtained by Kahl and Schwarze in 1988 for the same stage and same teeth. The delayed closure of the apices may be due to poor nutrition and socioeconomic status in this region. When the other stages were analyzed, 90% of males have attained 18 years at D stage itself and females at E stage. Thus, though the exact age cannot be ascertained, the Demirjian stages at which 18 years were attained can be determined.

Henceforth, we conclude that, (I) The presence of mineralization stages A-C shows that the child is less likely to be 18 years of age and stages D-H more likely to be 18 years of age, (II) Gender has an influence on growth of the third molars in which, males are seen to reach H stage earlier than females, (III) H stage was attained at 21.24 years in males and 22.86 years in case of females.

Further investigation with a larger sample size and from various ethnic origins and geographical areas should be carried out for the results to be applicable.

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